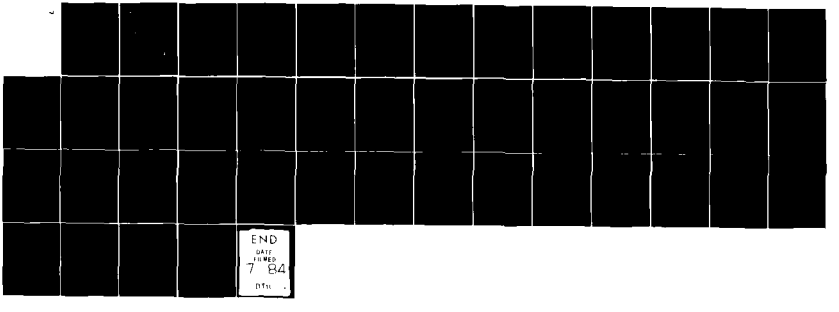
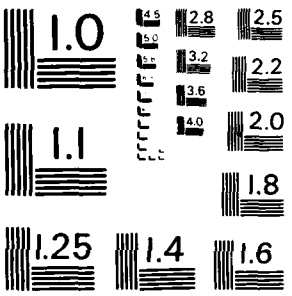
AD-A141 844 A GUIDE TO THE USE OF THE IWR INTERACTIVE RATIO FORECASTING PROGRAM(U) ARMY ENGINEER INST FOR WATER RESOURCES FORT BELVOIR VA C M DUNNING MAR 84 1/1

UNCLASSIFIED IWR-RR-84-R-3 F/G 5/11 NL





US Army Corps
of Engineers
Engineer Institute for
Water Resources

(12)

A Guide to the Use of the IWR Interactive Ratio Forecasting Program

March 1984

Research Report 84-R-3

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER IWR Research Report 84-R-3	2. GOVT ACCESSION NO. AD-A144 844	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A Guide to the Use of the IWR Interactive Ratio Forecasting Program		5. TYPE OF REPORT & PERIOD COVERED Research Report 84-R-3 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) C. Mark Dunning, Ph.D.		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Water Resources Support Center Institute for Water Resources Casey Building, Ft. Belvoir, VA 22060		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Water Resources Support Center Institute for Water Resources Casey Building, Ft. Belvoir, VA 22060		12. REPORT DATE March 1984 13. NUMBER OF PAGES 52
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES Ratio methods, forecasting program, program listing, basic ratio, annual ratio, ratio difference, shift share		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report provides instruction for using an interactive ratio forecasting program which can be used for developing forecasts of socioeconomic variables for small areas. Four commonly used methods are available in the program: basic ratio, average annual ratio, ratio difference, and shift share. These methods and their appropriate uses are described in the report.		

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

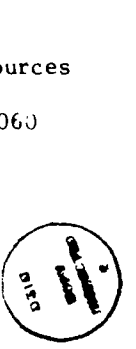
A Guide to the Use of the

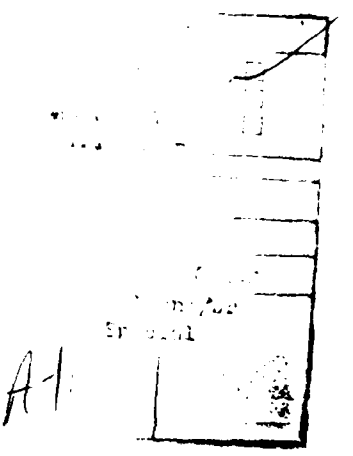
IWR Interactive Ratio Forecasting Program

by

C. Mark Dunning, Ph.D

Institute for Water Resources
Casey Building
Fort Belvoir, VA 22060





Research Report 84-R-3

March 1984

Acknowledgements

The version of the Interactive Ratio Forecasting Program described in this manual reflects comments of several individuals who reviewed an earlier version. In particular the helpful suggestions of Art Harnisch and Vanessa Arnot of Seattle District, Art Lewis of Southwestern Division, and Chuck Workman and Jody Rooney of St. Paul District are acknowledged. In addition, Marilyn Fleming of IWR provided invaluable advice and assistance in surmounting programming difficulties. The assistance of Kevin Alexander of IWR in transferring the program to the Harris System is also gratefully acknowledged.

Table of Contents

I. Introduction

This user manual describes a ratio forecasting program developed at IWR. Several common ratio forecasting methods are available to the analyst in the program. These methods and their appropriate uses are described in section 2 of this manual. A presentation of the procedures involved in running the program is provided in section 3.

The development of this program proceeded from the observation that many Corps study areas are too small to have forecasts available for them. Since many plan formulation and evaluation tasks require forecasts of study area variables such as population, income, and employment the Corps analyst often faces a dilemma in obtaining or generating such forecasts for small study areas.

The ratio methods described in this manual and available in the program offer a means to generate forecasts of socio-economic variables for small areas. The methods are widely used to generate population and employment forecasts (see for example, Shyrock, et al 1972; Hammond, 1973; Greenberg, et al, 1978; U.S. Bureau of the Census, 1972). It should be noted that other variables of interest to Corps planners (e.g. income, price levels, etc.) can be forecast using the ratio methods described in this manual. Essentially, these methods produce forecasts for small areas by allocating an independently derived forecast of the variable(s) for a larger area (state, SMSA) among smaller subcomponent areas on the basis of past ratios of these smaller areas to the larger area for the variable being forecast.

These methods can thus be used to "step-down" forecasts for larger areas to study areas using a definable analytic structure and framework. Ratio techniques are premised on the assumption that a small area will continue to have a similar relationship to a larger area. The methods, thus, are wholly "top-down" in the way in which small area forcecasts are derived. They do not take into account plans, expectations and develoments in the small area which may affect the historical relationship between small and large areas combined in the ratio(s) being used to generate forecasts. Judgment, on the part of the analyst, is thus necessary in using these techniques to generate forecasts just as it is necessary in adequately using any other forecasting method.

The central focuses of this manual are on the description of the ratio methods and on providing instruction on the use of a forecasting program. The manual is not intended to address the issue of the use and misuse of forecasts. Several sources provide detailed discussion of this topic (see for example, Armstrong, 1978; Pittenger, 1978; Robinson, 1982; Delli Priscoli, 1979; Oak Ridge Associated Universities, 1977). Nevertheless, it is important to emphasize that judgments on the analysts' part are important. In the case of ratio methods assumptions are important in reaching decisions about the change in the ratio of a smaller area to the larger area -- is the recent past likely to be more important than the distant past, are there major changes occurring in the small area which may affect the past trend? These and other issues must be addressed, and assumptions shaping the small area forecast clearly stated in the projection.

Appendix A of manual describes the operation of the program on the Harris 500 minicomputer. The listing of the program in FORTRAN IV is provided in Appendix B. A revision of this progam for the IBM personnal computer is planned.

2. Ratio Methods

The IWR Program offers four ratio forecasting methods: basic ratio, average annual ratio, ratio trend, and OBERs shift share. These methods are described in greater detail below.

2.1 Basic Ratio. This method uses the relationship between a small area and a larger parent area at one point in time to generate forecasts for the smaller area. This relationship is expressed as the ratio of the small area to the larger area:

(1) $r_t = S_t/P_t$

where:

S = small area population

P = parent area population

t = time

r = ratio

Generally, the ratio is computed for the most recent time period for which data for the small area and parent area are available. However, more distant data can be employed, if the analyst judges that the ratio from the most recent data available is not suitable.

Forecasts for the small area are computed by applying the ratio obtained in equation (1) to a forecast of the parent area:

(2) $S_{t+j} = r_t * P_{t+j}$

As noted previously the parent area forecast is externally derived. This forecast is obtained from other forecasting procedures at the local or national level (e.g. state or local planning agencies, OBERs).

The chief advantage of the basic ratio method is its ease of use. Only one data value for the small area and parent area is needed in combination with the parent area forecast in order to obtain a small area forecast. The primary potential disadvantage of the basic ratio method in comparison with the other methods described in this manual, however, is that it permits no use of information concerning how the relationship between the small area and parent area has changed over time. In periods of rapid change, when fundamental changes may be occurring in the small area, historical patterns of relationship may not be important. However, as a general rule, historical information about the past relationship of small to large areas can aid the analyst in making judgments about the future of the small area.

Example: Computation for population St. Clair County, Illinois using Basic Ratio Method

$r_{80} = S_{80}/P_{80}$

S_{80} = St. Clair County, 1980 (265,469)

P_{80} = Illinois, 1980 (11,418,461)

$r_{80} = .02325$

$S_{90} = r_{80} * P_{90}$

$= .02325 * 11,804,539$

$= 274,456$

2.2 Average Annual Ratio. The concept of an annual average rate of change is frequently used by Corps economists in computing benefits and costs. In the average annual ratio method for deriving small area forecasts, information about the ratio of the small to large area at two points of time is used to create an annual average change in the ratio. In this way a greater amount of information is employed in the forecasting process. The average annual method used in the IWR program has been derived from a method presented in White, et al 1953. The process is presented below:

(3) $y = r_t/r_{t-n}$

where:

y = ratio of ratios

r_t = ratio of small to large area at time t

r_{t-n} = ratio of small to large area at some previous time

(4) $i = t-(t-n)$ time interval between data points

(5) $A = \frac{1}{\sqrt[i]{y}} - 1$ average annual rate of change in ratio of small to large area

(6) $r_{t+j} = r_t * (1+j(A))$ ratio extrapolated j years into future on basis of annual average change

(7) $S_{t+j} = r_{t+j} * P_{t+j}$ forecast for small area at t+j

Example: Computation for St. Clair County, Illinois using average annual ratio method

$y = r_{80}/r_{50}$

$r_{80} = .02325$

$r_{50} = .02357$

$= .98642$

$i = t- (t-n)$

$= 80-50$

$= 30$

$$A = \frac{1}{.98642^{30} - 1}$$

$$= (\text{antilog } (\log .98642)/30) - 1$$

$$= -.000456 \text{ (average annual change = (-0.0456 percent)}$$

$$r_{80} = r_{90} (1 + 10 (-.000456))$$

$$= .02325 (.999544)$$

$$= .02314$$

$$S_{90} = r_{90} * P_{90}$$

$$= .02314 * 11,804,539$$

$$= 273,204$$

2.3. Ratio Difference Method. The ratio difference method inspects the change in ratios over time expressed as differences in ratios and projects on the basis of these changes. Thus, like the average annual method, this method offers the advantage of incorporating historical information. However, where the average annual change method assumes a continuous slope in the historical change in ratios, the ratio difference method allows the use of information about fluctuations in the ratios over time. The ratio difference method presented in the IWR program was developed on the basis of a description of this technique in Pickard (1980).

The method allows past ratios to be weighted according to the judgment of the analyst. In the IWR program the user has two choices for weighing past ratios. In the first option the most recent ratios are weighted more heavily

as an inverse proportion of this time from the period to be forecast. The second option allows the user to choose weighting factors (e.g. weight all ratios equally, weight past more heavily, etc.).

The ratio difference method is presented below:

(8) $D_t = r_t - r_{t-i}$ Difference of ratios where

r_{t-i} = ratio at some previous interval

(9) $\bar{D} = \sum_{t}^{t-n} W(D)$ Weighted average of differences; where weighting factors (w) are chosen by the user or are computed as below

(10) $w_j = \frac{1}{t+n - t_j} * 100$ factors weighted in inverse proportions to their distance in time from the period to be forecast.

(11) $S_{t+n} = (r_t + N(D)) * P_{t+n}$ Forecast for small area.

For example, for St. Clair County, Illinois:

$r_{50} = .02357$

$r_{60} = .02553$

$r_{70} = .02561$

$r_{80} = .02325$

$D_t = r_t - r_{t-i}$

$D_{50-60} = .00196$

$D_{60-70} = .00008$

$D_{70-80} = -.00236$

Weighting Factors:

For 1990 forecast

$$W_{50-60} = \frac{1}{1990-1960} * 100 = 3.3$$

$$W_{60-70} = \frac{1}{1990-1970} * 100 = 5$$

$$W_{70-80} = \frac{1}{1990-1980} * 100 = 10$$

$W_{50-60} = W_{50-60/EW} = .18$

$W_{60-70} = W_{60-70/EW} = .27$

$W_{70-80} = W_{70-80/EW} = .54$

$$\bar{D} = W_{70-80} (D_{70-8-}) + W_{60-70} (D_{60-70}) + W_{50-60} (D_{50-60})$$

$$= .54 (-.236) + .27 (.008) + .18 (.196)$$

$$= -.09$$

$$S_{90} = r_t + 1 (\bar{D}) * P_{90}$$

$$= .02325 - .0009 * 11,804,539$$

$$= 263,831$$

As can be seen in this example, a significantly lower forecast was derived using the ratio difference method than was obtained using either the basic ratio or average annual method. This lower forecast occurs because information from the most recent difference in ratios (1970-1980 period) was preserved by this method, and was weighted most heavily. In contrast, the average annual ratio method used information only from 1950 and 1980 to generate its forecast.

2.4. OBERs Shift Share. This procedure was developed by the Bureau of Economic Analysis. It combines a ratio component with a trend extrapolation of historical changes in the small area. This latter component is termed a shift factor and measures the difference in the small area's change accounted for by the simple ratio between the small area and the parent area, and the actual change observed. The method presented below was derived from Greenberg, et al, 1978.

The approach is presented as follows:

$$(12)\quad S_{t+m} = (r_t + b\,(t+m)) * P_{t+m}$$

In equation 12, the term r_t represents the ratio factor, while the b coefficient represents the "shift" component, showing how the relationship between small and parent areas has changed over time. This information is used to modify the current ratio (or an average ratio) r_t. The approach uses logarithms to compute the shift factor. Logarithms smooth the curve when rapid fluctuations in ratios have occurred. The computation of the shift factor b is shown below.

$$(13)\quad b = \frac{N \Sigma\,(\log t) * (\log r_t) - \Sigma\,(\log t) * \Sigma\,(\log r_t)}{N \Sigma\,(\log t)^2 - (\Sigma\,(\log t))^2}$$

As can be seen, equation 13 is the familiar ordinary least squares formula for computing the slope of a regression. This approach requires the use of a series of historical data. Generally, at least 10 historical data points should be used.

For example: for St. Clair County, Illinois:

Data:

Year	t	logt	(logt)2	r_t	log r_t	logt * log r_t
1950	1	.0000	.0000	.02357	-1.6276	0
1960	2	.3010	.0906	.02553	-1.5929	-0.4795
1970	3	.4771	.2276	.02561	-1.5916	-0.7594
1980	4	.6021	.3625	.02325	-1.6336	0.9836
		1.3802	.6807	-6.4458	-2.2225	

$$b = \frac{4 \Sigma (-2.2225) - (1.3802)(-6.4458)}{4 \Sigma (.6807) - (1.3802)^2}$$

$$= \frac{-8.8900 + 8.88965}{2.7228 - 1.9049}$$

$$= \frac{.0065}{.8179}$$

$$= .0079 \quad \text{(1.008 expressed as natural number)}$$

$$S90 = (\text{antilog } (r_{80} + b*\log 10)) * P_{90}$$

$$= (\text{antilog } (-1.6336 + .0079 * 1)) * 11,804,539$$

$$= \text{antilog } (-1.6257) * 11,804,539$$

$$= .0237 * 11,804,539$$

$$= 279,479$$

2.5 Summary. Four methods employing ratios to derive forecasts have been described in this section. It has been established that each method has different data requirements, makes different assumptions about the distribution of historical information used to derive forecasts, and employs

different mathematical procedures to generate forecasts. These differences in the methods are summarized in the table below. Having discussed the ratio methods in detail, the next section describes how to use the IWR ratio forecast program.

Table 1. Summary of Ratio Forecast Methods

	Basic Ratio	Average Annual	Ratio Differences	Shift Share	
Minimum No. of Historical Data Needed	1	2	3	10*	
Mathematical procedure to forecast	Simple ratio	Rate of Change	Weighted Average	OLS	
Weight of Historical Data	NA	Equal	Variable	Equal	

3. Using the Ratio Forecast Program.

The ratio forecast program performs the following functions:

- o generates forecasts for small areas using any of the four ratio methods
- o generate a "composite table" of the four ratio methods so that values can be compared
- o makes revisions to data erroneously entered
- o generates forecasts for multiple small areas which are subcomponents of the same parent area.

o reconciles forecasts of multiple small areas so that they sum to the value of parent forecast.

3.1. Operation of main program. The operation of the program is shown below. User supplied inputs are underlined.

3.1.1. Initial Data Entry. On first accessing the program, the user is prompted to enter data:

Computer Prompts	Remarks
ENTER YEARS FOR WHICH YOU HAVE DATA	
Enter 0 to Stop 1: 1950 2: 1960 3: 1970 4: 1980 5: 0	Enter years for which you have both a value for the parent area, and a value for the small area. To stop enter a 0.
ENTER NAME OF PARENT AREA: ILLINOIS	Enter name or other identification for parent area (up to 10 characters)
ENTER DATA FOR ILLINOIS FOR 1950: 8738000 1960: 10280000 1970: 11137000 1980: 11418461	
ENTER NAME OF SMALL AREA: ST. CLAIR	Enter name of other identification for small area (up to 10 characters)
ENTER DATA FOR ST. CLAIR FOR 1950: 205995 1960: 262509 1970: 285176 1980: 265469	

Enter Years To Be Forecast Enter 0 to STOP	Enter years for which forecast is desired, and for which a parent area forecast is available

1 : 1990
2 : 2000
3 : 0

ENTER FORECAST FOR ILLINOIS FOR

1990: 11804539 2000: 12263810	Data entry is now complete, program exits to main menu.

3.1.2. Main Menu. Seven options are provided in the main menu. The main menu is displayed in full once, and in an abbreviated form thereafter. The full menu can be displayed by entering a number other than 1 through 7 in response to the menu prompt.

Computer Prompts	Remarks
MAIN MENU CHOICES:	
(1) ENTER NEW PARENT AREA DATA	See Section 3.1.3
(2) ENTER NEW SMALL AREA DATA	See Section 3.1.4
(3) ENTER NEW PARENT AREA FORECAST	See Section 3.1.5
(4) EXAMINE/CHANGE INPUT VALUES	See Section 3.1.6
(5) ACCESS FORECAST MENU	See Section 3.1.7
(6) RECONCILE SMALL AREA FORECASTS	See Section 3.1.8
(7) END	
or MAIN MENU CHOICE (1-7)	

3.1.3. Enter new Parent Area Data. If the user decides to test the sensitivity of forecasts using a different parent area (e.g. substituting SMSA data for state data) choosing option 1 on the main menu will put the user back into the data entry mode described in 3.1.1 for parent area data. After entering new parent area data the program returns to the main menu.

3.1.4. Enter New Small Area Data. Choosing option 2 of the main menu enables the user to enter data for a different small area. Prompts are the same as described in 3.1.1.

3.1.5. Enter New Parent Area Forecast. Selecting option 3 of the main menu enables the user to substitute different forecasts for the parent area. This option can be useful if the analyst would like to compare the small area forecasts among several competing parent area forecasts embodying different assumptions, etc.

3.1.6. Examine/Change Input Values (option 4). Option 4 of the main menu enables users to correct individual data entries which were incorrectly entered.

Computer Prompts

INPUT VALUES ARE AS FOLLOWS

YEAR	ILLINOIS	CALHOUN
1950	8738000.	5600.
1960	10280000.	6500.
1970	11137000.	6700.
1980	11418461.	8000.

FORECAST DATA

YEAR	ILLINOIS
1990	12090000.
2000	13877000.
2010	15380000.
2020	17500000.

DO YOU WANT TO MAKE CHANGES IN DATA? (Y or N): Y

SELECT CATEGORY OF ITEM TO BE CHANGED

(1) YEAR FOR WHICH YOU HAVE DATA
(2) PARENT AREA DATA
(3) SMALL AREA DATA
(4) YEARS TO BE FORECAST
(5) PARENT AREA FORECAST

3 — The "3" entered indicates that small area data is to be changed.

1 5600
2 6500.
3 6700.
4 8000. — Program lists data entries with an identification number.

ENTER NUMBER OF ITEM TO BE CHANGED: 3

Old Value = 6700. New Value = 6800. — Program prompts for replacement number.

MORE CHANGES? (Y or N)
N — If there are more data changes to be made enter Y.

DO YOU WANT TO PRINT DATA AGAIN? (Y or N) N — To inspect data enter "Y", a "N" response returns to the menu for selecting ratio approaches.

3.1.7. Access Forecast Menu (Option 5). The operation of the Forecast Menu is described more fully in section 3.2. After accessing the forecast menu the program returns to the main menu.

3.1.8. Reconcile Small Area Forecasts (Option 6). This portion of the program can be called into operation when the analyst has generated forecasts for several small areas which encompass a parent area. Examples include forecasts for SIC categories comprising a parent area employment forecast, forecasts for townships comprising a county for which an external forecast is available. It is unlikely that the small area forecasts will exactly total the value of the parent area. The reconciliation subroutine scales the small area forecasts so that they sum to the value of the parent area forecast. The scaling factor used is the ratio of the summed small area forecasts to the

parent area forecast. Each small area forecast is then multiplied by this scaling factor to generate the reconciled small area forecasts. If the small areas do not entirely encompass the parent area a "Balance" is automatically computed representing that portion of the parent area not included in the small areas. A forecasted "Balance" is computed on the basis of the most recent ratio of the "Balance" to the parent area. This balance is then treated just like a small area in the scaling routine.

```
MAIN MENU CHOICE (1-7):  6
   RECONCILED FORECAST FOR SMALL AREAS
   PARENT AREA= ILLINOIS

SMALL AREA          1990          2000          2010          2020
ST. CLAIR         273595.       283802.       320717.      3550023.
CALHOUN             9121.         9913.        11633.        13324.
BALANCE         11521824.     11970095.     13544650.     15011653.

   TOTAL        11804539.     12263810.     13877000.     15380000.

MAIN MENU CHOICE (1-7):
```

In the above example, the program has adjusted the forecast values of two small areas which do not entirely encompass their parent area.

3.1.9. END (Option 7). This option ends the program.

3.2. Forecast Menu. As noted above selecting option 5 on the main menu accesses the forecast menu. Like the main menu, after the user has viewed the full menu once an abbreviated form is shown. If the user wants to see the entire menu it can be accessed by entering any number besides the choices shown.

Computer Prompts

(1)	BASIC RATIO METHOD	Section 3.2.1
(2)	ANNUAL AVERAGE RATIO	Section 3.2.2
(3)	RATIO DIFFERENCE METHOD	Section 3.2.3
(4)	SHIFT SHARE	Section 3.2.4
(5)	COMBINATION TABLE	Section 3.2.5
(6)	EXIT TO MAIN MENU	Section 3.2.6

or

FORECAST MENU CHOICE (1-6):

3.2.1. Basic Ratio Method (Option 1)

Computer Prompts

SELECT ONE OF THE FOLLOWING RATIOS:

(1) 1950 .02357 Enter number of choice
(2) 1960 .02554
(3) 1970 .02561
(4) 1980 .02325

FORECAST FOR ST. CLAIR
RATIO = .02325

1990: 274445.
2000: 285123.
2010: 322628.
2020: 357571.

DO YOU WANT TO RECONCILE THIS FORECAST?
(Y OR N): N
DO YOU WANT TO TRY ANOTHER RATIO?
(Y OR N): N

Program then asks if this forecast will be used in the reconciliation routine - see section 3.1.8. A response of "Y" allows choice of another ratio. A response of "N" to this prompt returns the user to the main menu.

3.2.2. Average Annual Ratio (Option 2).

Computer Output

FORECAST USING AVERAGE ANNUAL FACTOR OF - .00046

YEAR	FORECAST
1990	273173.
2000	282480.

DO YOU WANT TO RECONCILE THIS FORECAST? (Y or N)

See above in basic ratio comments concerning this question.

3.2.3 Ratio Difference (Option 3).

Computer Output

```
DIFFERENCE IN RATIOS ARE AS FOLLOWS:

1950-1960   .0019613
1960-1970   .0000703
1970-1980  -.0023571

WHICH DIFFERENCE METHOD WOULD YOU LIKE
TO USE:  1
   (1)  Proportional Weights
   (2)  Weighted Average

WEIGHTS FOR 1990 ARE:
1950-1960      .182
1960-1970      .273
1970-1980      .545

FORECAST FOR 1990 =    263704.

WEIGHTS FOR 2000 ARE:

1950-1960      .231
1960-1970      .308
1970-1980      .462
FORECAST FOR 2000 =    270071.
```

As described in section 2.3. User has option of entering factors. By Entering a "1" weighting factors are pre-selected as discussed in section 2.3. Entering a "2" enables the user to specify their own weights. User-specified weights should sum to 1.0.

DO YOU WANT TO RECONCILE THIS FORECAST? (Y or N)

See comment in section 3.3.2 concerning this question.

3.2.4 Shift Share (Option 4).

```
IMPLICIT SHIFT FACTOR IS  1.00769
SELECT RATIO FOR USE:  1

(1)  .023  (1980)
(2)  AVERAGE RATIO = .024

YEAR      FORECAST
1990      279332.
2000       291746.
```

Program offers users opportunity to use most recent ratio or an average ratio computed over the historical time period.

DO YOU WANT TO RECONCILE THIS FORECAST? (Y or N)

See comment in section 3.2.1 concerning this question.

3.2.5. Combination Table (Option 5). In many cases an analyst might like to compare the forecasts generated by each of the ratio methods presented in this manual. Option 5 presents a comparative table for the small area containing basic ratio, average annual, ratio difference, and shift share forecasts. The basic ratio forecast uses the most recent ratio, the ratio difference forecast uses the proportional weights method, and the shift share forecast employs the most recent ratio to serve as share factor.

Computer Output

COMPARATIVE FORECASTS FOR ST. CLAIR

HISTORICAL DATA

YEAR	ILLINOIS	ST. CLAIR
1950	8738000.	205995.
1960	10280000.	262509.
1970	11137000.	285176.
1980	11418461.	265469.

FORECAST

YEAR	ILLINOIS	ST. CLAIR			
		BASIC RATIO	AVERAGE AANNUAL	RATIO DIFFERENCE	SHIFT SHARE
1990	11804539.	274445.	273173.	263704.	279332.
2000	12263810.	285123.	282480.	270071.	291746.
2010	13877000.	322628.	318143.	302652.	331150.
2020	15380000.	357571.	350944.	332797.	367827.

After printing the comparative table, the program returns to the main menu. If the user chooses, individual forecast approaches can be accessed and various sub-options in the approaches (e.g. use of different share factor, different basic ratio, different weighting factors) explored. Similarly, if the user wants to use a forecast in the comparative table in a reconciliation, the particular forecast must be reproduced by accessing the relevant ratio forecast option (1-4) in the forecast menu.

3.2.6. Exit to Main Menu (Option 6). Option 6 returns the user to the main menu.

4. Summary

This user manual has described four ratio methods which can be used to generate forecasts for socio-economic variables in small areas. It is felt that these methods offer a means for providing Corps planners with a way to generate forecasts of population, income, and employment for small study areas. The IWR program presented offers a way to relieve the computational tedium associated with using these methods. While the methods are easy to use and conceptually straightforward, it should again be emphasized that the role of professional judgment on the part of the analyst is just as essential in the use of these methods as it is in using any other forecasting techniques.

References

Armstrong, R. 1978. Long Range Forecasting. New York: Wiley

Delli Priscoli, J. 1979. "Future Thinking: Fad or Necessity" Water Spectrum. Ft. Belvoir, VA (Spring).

Greenberg, M.D. Krueckeberg, and C. Michaelson. 1978. Local Population and Employment Projection Techniques. Center for Urban Policy Research; Rutgers University.

Hammond, D. 1973. Linn County Population and Employment. Linn County (IA) Regional Planning Commision. Cedar Rapids, IA.

Oak Ridge Associated Universities. 1977. Population Forecasting for Small Areas. Oak Ridge, TN.

Pickard, J. 1980. Linear Ratio-Trend Population Projections Methodology. Appalachian Regional Commission. Washington, DC.

Pittenger, D. 1978. The Role of Judgment, Assumptions, Techniques and Confidence Limits in Forecasting Population. Socio-Economic Planning Sciences Vol. 12 pp 271-276.

Robinson, J. 1982. Backing Into the Future. Technological Forecasting and Social Change. 21:229-240.

Shyrock, H., J. Siegel, et al. 1971. The Methods and Materials of Demography. U.S. Bureau of the Census. Washington, DC. U.S. Government Printing Office

U.S. Census Bureau. 1972. Preliminary Projections of the Population of States: 1975 to 1990. Series P-25, Number 477. (March)

White, H., S. Siegel and B. Rosen. 1953. Short Cuts in Computing Ratio Projections of Population. Agricultural Economics 5(1). January.

APPENDIX A

Using the Ratio Forecasting Program on the Harris Computer

Appendix A
Using the Ratio Forecasting Program on the Harris Computer

To use the RFP enter the following statements after logging onto the Harris:

```
FORTRAN, IRFP
FR,5
ASSIGN, 5=FORDATA
VXECUTE
```

NOTE: In this instance name of RFP is IRFP

Note that the ASSIGN, 5 = FORDATA creates an output file (FORDATA) which can be stored and accessed at a later date. In this way RFP can be run on a CRT and the output retrieved and printed later. The output can be retrieved by bringing it into Editor and listing it.

APPENDIX B

FORTRAN 66 Listing of REP

```
C      ** RATIO ESTIMATOR PROGRAM VERSION [illegible]
C      ** MODIFIED FOR THE PRO[illegible]
C      ** ALEXANDER, U.S. ARMY [illegible]
C      ** WATER RESOURCES, FT. BELVOIR, VA.
C
       COMMON /ONE/ I,D(15),N,M(15),A(15),B(15),
      1WT(15),JA,RA,PA(15,2),WT1(15),W,M1(15),IT2
      2,JCOUNT,A(15),B(15),RA
       COMMON /TWO/ ICOUNT,PA(15,2),NN(15,4),IT,IT1,IT2,JA,RA
C
C      **  INPUT OF DATA
C
       WRITE(3,12)
       N 20
       ICOUNT 0
       JCOUNT 0
       IT 0
12     FORMAT(5X,"ENTER YEARS FOR WHICH YOU HAVE DATA"
      15X,"ENTER 0 TO STOP",/)
7      FORMAT(I2)
       DO 10 IA 1,N
       WRITE (3,5) IA
5      FORMAT(T15,I2,1X,":",5X)
       READ (3,9) IY(IA)
       J=IA
       IF(IY(IA) .EQ. 0)GO TO 11
10     CONTINUE
11     CONTINUE
9      FORMAT(I4)
       J=J - 1
22     WRITE (3,6)
       ICOUNT=ICOUNT + 1
6      FORMAT (/5X,"ENTER NAME OF PARENT AREA:",5X)
       READ (3,4) (PA(ICOUNT,I),I=1,2)
4      FORMAT(2A6)
       WRITE (3,23) (PA(ICOUNT,I),I=1,2)
23     FORMAT(/5X,"ENTER DATA FOR",1X,2A6,1X,"NOTE INCLUDE DECIMAL!!!",/
       DO 25 IA=1,J
       WRITE (3,24) IY(IA)
24     FORMAT(T15,I4,2X,":",5X)
       READ (3,17) A(IA)
17     FORMAT(F7.0)
25     CONTINUE
       JA=0
       IF(IT .EQ. 0)GO TO 26
       GO TO 83
26     WRITE(3,18)
       JCOUNT=JCOUNT + 1
18     FORMAT(/5X,"ENTER NAME OF SMALL AREA:",5X)
       READ (3,4000) (NN(JCOUNT,I),I=1,4)
       WRITE (3,4001) (NN(JCOUNT,I),I=1,4)
 4000  FORMAT(4A3)
 4001  FORMAT(/5X,"ENTER DATA FOR ",4A3," NOTE: INCLUDE DECIMAL!!!"/)
       JA=JA + 1
       IT2=0
       RA=0
       DO 30 IA=1,J
       WRITE (3,28) IY(IA)
28     FORMAT(T15,I4,2X,":",5X)
21     READ (3,17) B(IA)
       IF(B(IA) .LT. A(IA))GO TO 29
       WRITE (3,44)
44     FORMAT(T5,"SMALL AREA LARGER THAN PARENT AREA, RE ENTER",/)
       GO TO 21
```

```
C
C      *** INPUT OF FORECAST DATA
C
      WRITE (3,123)
123   FORMAT(/5X,"ENTER YEARS TO BE FORECAST, ONE PER LINE:",/)
      DO 125 IB=1,N
      WRITE (3,5) IB
      READ (3,7) IYB(IB)
      K2=IB
      IF(IYB(IB) .EQ. 0)GO TO 126
125   CONTINUE
126   CONTINUE
      K2=K2 - 1
201   WRITE (3,200) (PA(ICOUNT,I),I=1,2)
206   FORMAT(/5X,"ENTER FORECAST FOR",1X,2A6,1X,"NOTE INCLUDE DECIMAL"
     @",/)
      DO 135 IB=1,K2
      WRITE (3,205) IYB(IB)
205   FORMAT(T15,I4,":",5X)
      READ (3,17) P(IB)
135   CONTINUE
      GO TO 83
C
C      *** ECHO OF INPUT VALUES
C
34    WRITE (3,35) (PA(ICOUNT,I),I=1,2),(NN(JCOUNT,I),I=1,4)
35    FORMAT(/5X,"INPUT VALUES ARE AS FOLLOWS:"//
     @T15,"YEAR",6X,2A6,6X,4A3)
      DO 55 IA=1,J
      WRITE (3,40) IY(IA),A(IA),B(IA)
40     FORMAT(T15,I4,6X,F10.0,6X,F10.0)
55    CONTINUE
      WRITE (3,92) (PA(ICOUNT,I),I=1,2)
92    FORMAT(/T23,"FORECAST DATA",//T15,"YEAR",6X,2A6)
      DO 94 IA=1,K2
      WRITE (3,96) IYB(IA),P(IA)
96    FORMAT(T15,I4,6X,F10.0)
94    CONTINUE
C
C      *** CHANGES IN DATA AND WRITING DATA TO FILE SUB CALLS
C
      WRITE (3,81)
81    FORMAT(/5X,"DO YOU WANT TO MAKE CHANGES IN DATA? (Y OR N):",5X)
      READ (3,82) IAN
      IF(IAN .NE. 1HY)GO TO 83
82    FORMAT(A1)
      CALL CHANGE
      GO TO 83
83    CONTINUE
      CALL FILEIN
      IYE=IY(J)
      IYBT=IY(1)
      IX=IYE - IYBT
70    FORMAT(5X,"PERIOD",1X,I2,":",5X)
33    DO 32 IA=1,J
      R(IA)=B(IA)/A(IA)
      RA=RA + R(IA)
32    CONTINUE
      AV=R(J)/R(1)
      AA=EXP(ALOG(AV)/IX) - 1
51    GO TO 187
```

```
      U=I3.EQ.0)GOTO 7
      WRITE (3,77)
77    FORMAT(/5X,"FORECAST MENU CHOICE (1 6) OR 0 TO SEE MENU",5X)
      GO TO 79
74    WRITE  3,75)
75    FORMAT(/5X,"FORECAST MENU CHOICES:",/
     1/T15,"(1) BASIC RATIO METHOD",/T15,"(2) ANNUAL AVERAGE RATIO"
     2,/T15,"(3) RATIO DIFFERENCE METHOD",/T15,"(4) SHIFT SHARE",/,
     3T15,"(5) COMBINATION TABLE",/T15,"(6) EXIT TO MAIN MENU",/)
79    READ (3,80) IS
80    FORMAT(I1)
      IF(IS .GT. 6 .OR. IS .LT. 1)GO TO 74
      IT=1
      GO TO(95,145,142,144,191,707),IS
C
C     *** BASIC RATIO METHOD ***
C
95    CONTINUE
      WRITE (3,100)
      WRITE (5,100)
100   FORMAT(5X,"SELECT ONE OF THE FOLLOWING RATIOS:",/)
      DO 105 IA=1,J
      WRITE (3,103) IA,IY(IA),R(IA)
      WRITE (5,103) IA,IY(IA),R(IA)
103   FORMAT(T15,"(",I2,")",1X,I4,3X,F7.5)
105   CONTINUE
      WRITE (3,106)
106   FORMAT(/)
      READ (3,80) K
      WRITE (3,115) (NN(JCOUNT,I),I=1,4),R(K)
      WRITE (5,115) (NN(JCOUNT,I),I=1,4),R(K)
115   FORMAT(/5X,"FORECAST FOR",1X,4A3,/5X,"RATIO=",1X,F6.5,/)
      DO 140 IB=1,K2
      F(IB)=R(K) * F(IB)
      WRITE (3,127) IYB(IB),F(IB)
      WRITE (5,127) IYB(IB),F(IB)
127   FORMAT(5X,I4,1X,":",1X,F9.0)
140   CONTINUE
      WRITE (3,700)
700   FORMAT(/5X,"DO YOU WANT TO RECONCILE THIS FORECAST? (Y OR N):",5X)
      READ (3,82) IAN
      IF(IAN .NE. 1HY)GO TO 151
      CALL PRECON
      GO TO 187
151   WRITE (3,701)
701   FORMAT(/5X,"DO YOU WANT TO TRY ANOTHER RATIO(Y OR N):",5X)
      READ (3,82) IAN
      IF (IAN .NE. 1HY)GO TO 187
      GO TO 95
191   CALL COMP
      GO TO 187
142   CALL DIFF
      GO TO 187
144   CALL SHIFT
      GO TO 187
C
C     *** ANNUAL AVERAGE RATIO ***
C
145   WRITE (3,150) (NN(JCOUNT,I),I=1,4),AA
      WRITE (5,150) (NN(JCOUNT,I),I=1,4),AA
150   FORMAT(5X,"FORECAST FOR",1X,4A3,1X,"USING AVERAGE ANNUAL",
     @/" FACTOR OF",1X,F7.5,/
     @/T15,"YEAR",8X,"FORECAST")
      DO 160 IB=1,K2
      XI2=FLOAT(IYB(IB) - IYE)
      F(IB)=0
```

```
197         F(IB)=(R(J) * (1 + XI2 * AA)) * F(IB)
198         WRITE (3,157) IYB(IB),F(IB)
199         WRITE (5,157) IYB(IB),F(IB)
200 157     FORMAT(15X,I4,6X,F9.0)
201 160     CONTINUE
202         WRITE (3,700)
203         READ (3,82) IAN
204         IF(IAN .NE. 1HY)GO TO 187
205         CALL PRECON
206 190      FORMAT(F7.0)
207 187     CONTINUE
208 707     IF(IT .EQ. 0)GO TO 182
209         WRITE (3,705)
210 705     FORMAT(/5X,"MAIN MENU CHOICE (1-7):  OR 0 TO SEE MENU",5X)
211         GO TO 706
212 182     CONTINUE
213         WRITE (3,180)
214 180     FORMAT(/5X,"MAIN MENU CHOICES:",//
215        1T15," 1- ENTER NEW PARENT AREA DATA",/
216        2T15," 2- ENTER NEW SMALL AREA DATA",/
217        3T15," 3- ENTER NEW PARENT AREA FORECAST",/
218        4T15," 4- EXAMINE/CHANGE INPUT VALUES",/
219        5T15," 5- ACCESS FORECAST MENU",/
220        6T15," 6- RECONCILE SMALL AREA FORECASTS",/
221        7T15," 7- END",/)
222 706     READ (3,185) IPLY
223         IF(IPLY .GT. 7 .OR. IPLY .LT. 1)GO TO 182
224 185     FORMAT(I1)
225         GO TO(22,26,201,34,73,104,183),IPLY
226 184     CALL RECON
227         GO TO 187
228 183     STOP
229         END
230 C
231 C       *** RATIO DIFFERENCE SUBROUTINE ***
232 C
233         SUBROUTINE DIFF
234 C
235         COMMON /ONE/ J,D(15),R(15),IY(15),K2,IYB(15),F(15),
236        1WF(15),JA,RC(20,20),WT1(15),WT(15),F(15),NN(15,4),
237        2JCOUNT,A(15),B(15),RA
238 C
239         DN=0
240 700     FORMAT(/5X,"DO YOU WANT TO RECONCILE THIS FORECAST",/
241        1"(Y OR N):")
242 82      FORMAT(A1)
243         XNN1=FLOAT(IY(2))
244         XNN2=FLOAT(IY(1))
245         K5=J 1
246         DO 250 IB=1,K5
247         D(IB)=R(IB + 1) - R(IB)
248         DN=DN + D(IB)
249 250     CONTINUE
250         D1=XNN1   XNN2
251         D3=0
252         DO 255 IB=1,K5
253         D2=(IY(IB + 1) - IY(IB))/D1
254         D3=D3 + D2
255 255     CONTINUE
256         IF(IT2 .GT. 0)GO TO 273
257         WRITE (3,260)
258         WRITE (5,260)
259 260     FORMAT(5X,"DIFFERENCES IN RATIOS ARE AS FOLLOWS:",/)
260         DO 270 IB=1,K5
261         WRITE (3,265) IY(IB),IY(IB + 1),D(IB)
262         WRITE (5,265) IY(IB),IY(IB + 1),D(IB)
```

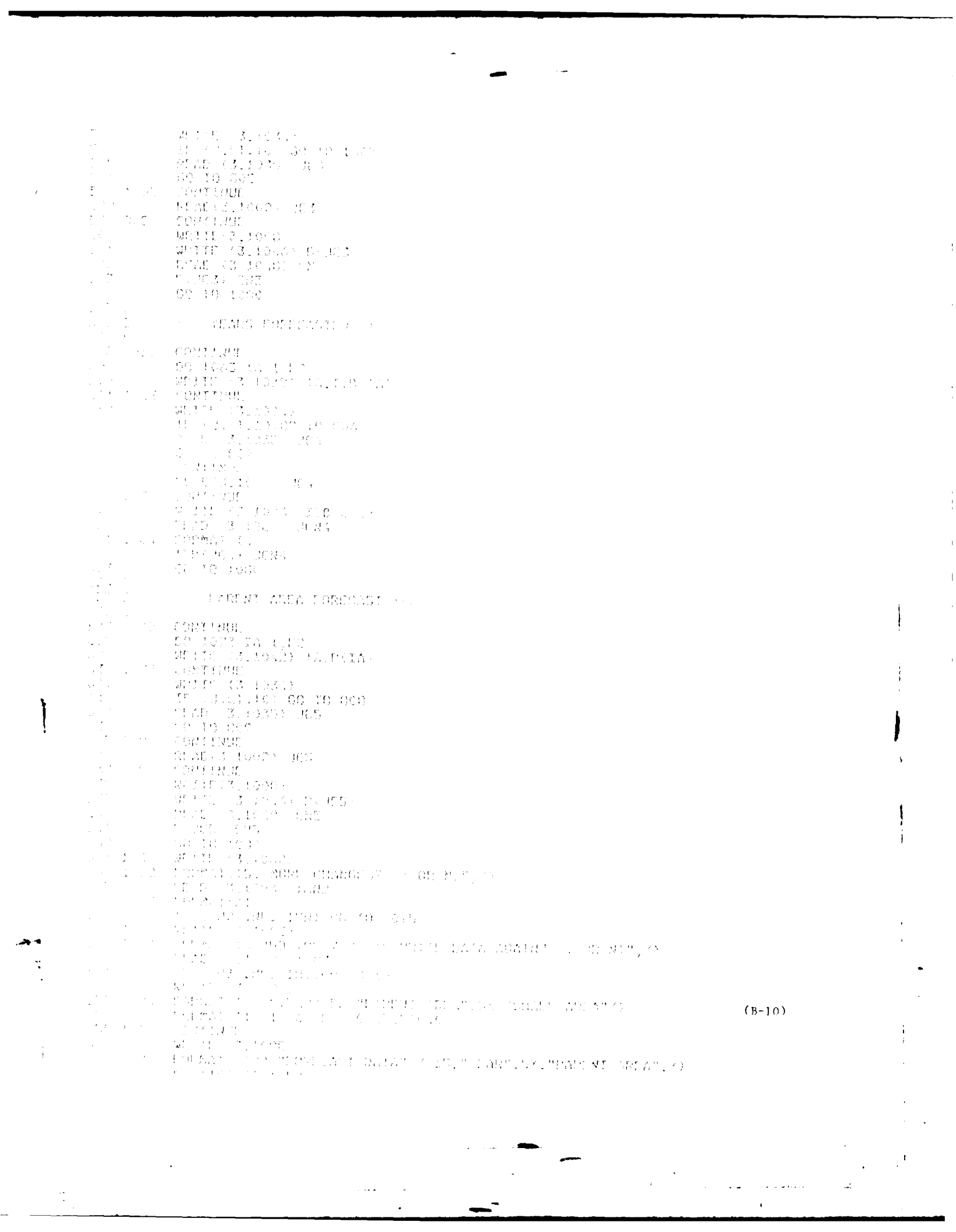
```
263 265   FORMAT(I10,I4," ",I4,5X,F9.7)
264 270   CONTINUE
265 273   WRITE (3,275)
266 275   FORMAT(/,5X,"WHICH DIFFERENCE METHOD WOULD YOU LIKE TO USE:",/
267      1T15,"(1) PROPORTIONAL WEIGHTS",/T15,"(2) WEIGHTED AVERAGE",/)
268       READ (3,280) IA2
269 280   FORMAT(I1)
270       IF(IA2 - 1) 285,285,300
271 285   CONTINUE
272       WRITE (5,286)
273 286   FORMAT (//,"PROPORTIONAL WEIGHTS METHOD",//)
274       WRITE (3,283) (NN(JCOUNT,I),I=1,4)
275       WRITE (5,283) (NN(JCOUNT,I),I=1,4)
276 283   FORMAT(5X,"FORECAST FOR",1X,4A3,/)
277       DO 295 IA=1,K2
278       DO 290 IB=1,K5
279       WT1(IB)=0
280       WT(IB)=0
281 290   CONTINUE
282       SUM1=0
283       DBAR=0
284       A1=FLOAT(IY3(IA)   IY(1))/D1
285       DO 220 IB=1,K5
286       WT1(IB)=(1./FLOAT(IYB(IA) - IY(IB + 1))) * 100
287       SUM1=SUM1 + WT1(IB)
288 220   CONTINUE
289       DO 221 IB=1,K5
290       WT(IB)=WT1(IB)/SUM1
291       WX=WT(IB) * D(IB)
292       DBAR=WX + DBAR
293 221   CONTINUE
294       WRITE (3,360) IYB(IA)
295       WRITE (5,360) IYB(IA)
296 360   FORMAT(/5X,"WEIGHTS FOR",1X,I4,1X,"ARE:",/)
297       DO 365 IB=1,K5
298       WRITE (3,361) IY(IB),IY(IB+1),WT(IB)
299       WRITE (5,361) IY(IB),IY(IB + 1),WT(IB)
300       WRITE (5,367) IYB(IA),F(IA)
301 361   FORMAT(5X,I4," ",I4,5X,F4.3)
302 365   CONTINUE
303 369   F(IA)=0
304       F(IA)=(R(J) + A1 * DBAR) * F(IA)
305 367   FORMAT(5X,"FORECAST FOR",1X,I4,1X,"=",1X,F11.0)
306       WRITE (3,317) IYB(IA),F(IA)
307 295   CONTINUE
308       WRITE (3,299)
309       READ (3,82) IAN
310       IF(IAN .NE. 1HY)GO TO 350
311       CALL PRCOOM
312       GO TO 350
313 C
314 C
315 300   CONTINUE
316       WRITE (5,304)
317 304   FORMAT(//,"WEIGHTED AVERAGE METHOD",//)
318       WRITE (3,305)
319 305   FORMAT(5X,"ENTER WEIGHTING FACTORS FOR DIFFERENCES:",/)
320       F4A=0
321       DO 310 IB=1,K5
322       WRITE (3,315) IY(IB),IY(IB + 1),D(IB)
323 315   FORMAT(T10,I4,"-",I4,5X,F9.7)
324       READ (3,320) WF(IB)                                    (B-5)
325 320   FORMAT(F4.3)
326       F3A=WF(IB) * D(IB)
327       F4A=F4A + F3A
328 310   CONTINUE
```

```
329         WRITE (3,325)
330 325     FORMAT(5X,"FACTORS WHICH AFFECTED [illegible]
331        1/T15,"PERIOD",5X,"DIFFERENCE",5X,"RE[illegible]
332         DO 330 IB=1,K5
333         WRITE (3,335) IY(IB),IY(IB + 1),D(IB),WT1(IB)
334         WRITE (5,335) IY(IB),IY(IB + 1),D(IB),WT1(IB)
335 335     FORMAT(T12,I4," ",I4,8X,F9.7,5X,F5.3
336 330     CONTINUE
337         WRITE (3,340) (NN(JCOUNT,I),I=1,4)
338         WRITE (5,340) (NN(JCOUNT,I),I=1,4)
339 340     FORMAT(5X,"FORECAST FOR",1X,4A5,1X,"USING",
340        15X,"WEIGHTED AVERAGE:",/)
341         DO 350 IB=1,K2
342         F(IB)=0
343         B1I=FLOAT(IYB(IB)   IY(J))/D1
344         F(IB)=((F4A * B1I) + R(J)) * P(IB)
345         WRITE (3,345) IYB(IB),F(IB)
346         WRITE (5,345) IYB(IB),F(IB)
347 345     FORMAT(T15,I4,5X,F11.0)
348 350     CONTINUE
349         WRITE (3,700)
350         READ (3,82) IAN
351         IF(IAN .NE. 1HY)GO TO 352
352         CALL PRECON
353         IT2=1
354         GO TO 352
355 352     CONTINUE
356         RETURN
357         END
358 C
359 C       *** SHIFT SHARE METHOD SUBROUTINE ***
360 C
361         SUBROUTINE SHIFT
362 C
363         COMMON /ONE/ J,D(15),R(15),IY(15),K2,IYB(15),P(15),
364        1WF(15),JA,RC(20,20),WT1(15),WT(15),F(15),NN(15,4),
365        2JCOUNT,A(15),B(15),RA
366 C
367         D1=FLOAT(IY(2) - IY(1))
368         SIX=0
369 700     FORMAT(/5X,"DO YOU WANT TO RECONCILE THIS FORECAST",/
370        1"(Y OR N):")
371 82      FORMAT(A1)
372         WRITE (5,401)
373 401     FORMAT(//,1X,"SHIFT SHARE METHOD USED",//)
374         XY=0
375         SXY=0
376         SX=0
377         SY=0
378         DO 400 IE=1,J
379         DT=FLOAT(IE)
380         DYX=ALOG(DT)
381         SIX=SIX + DYX**2
382         RY=ALOG(R(IE))
383         XY=DYX * RY
384         SXY=SXY + XY
385         SX=SX + DYX
386         SY=SY + RY
387 400     CONTINUE
388         AVE=RA/J
389         DNUM=(J * SXY) - SX * SY
390         DENOM=(J * SIX) - SX**2
391         BB=DNUM/DENOM
392         BA=EXP(BB)
393         WRITE (3,405) BA
394         WRITE (5,405) BA
```

```
C
C      *** RECONCILIATION SUBROUTINE ***
C
       SUBROUTINE RECON
C
       COMMON /ONE/ J,D(15),R(15),IY(15),K2,IYB(15),P(15),
      1WF(15),JA,RC(20,20),WT1(15),WT(15),F(15),NN(15,5),
      2JCOUNT,A(15),B(15),RA
       COMMON /TWO/ ICOUNT,FA(15,2),SUMB,RB(15),IYE,AA,FW(15),OS(15)
C
       DIMENSION SAFR(20,20),BF(15)
       RBAL=(A(J) - SUMB)/A(J)
       IC=JCOUNT
       DO 510 IB=1,K2
       BF(IB)=P(IB) * RBAL
510    CONTINUE
       DO 550 IB=1,K2
       XSUM=0
       N=0
       SUM=0
       SUM2=0
```

```
C
C     *** CHANGES IN INPUT DATA SUBROUTINE ***
C
      SUBROUTINE CHANGE
C
      COMMON /ONE/ LD(15),R(15),IY(15),K2,IYR(15),R(15)
```

```
      [illegible] U [illegible] I5 ,VI I5 ,T (I0),NN I5,[illegible],JCOUNT,
      [illegible] I5,IA
      [illegible]
      [illegible] CATEGORY OF ITEM TO BE CHANGED",/
      [illegible] FOR WHICH YOU HAVE DATA"/
      [illegible] DATA" [illegible] I5, [illegible] SMALL AREA DATA",/
      [illegible] TO BE FORECAST"[illegible]
      [illegible] PARENT AREA FORECAST" [illegible]
      READ [illegible]
      FORMAT[illegible]
      GO TO(1020,[illegible],1050,[illegible],1070),[illegible]X
C
C     [illegible]EAR [illegible]
C
[illegible] CONTINUE
      DO 1032 IA=1,[illegible]
      WRITE (3,1037) IA,IY(IA)
[illegible] FORMAT(I5,[illegible],I5)
[illegible] CONTINUE
      WRITE (2,[illegible])
[illegible] FORMAT(I5,"[illegible] NUMBER [illegible] ITEM TO BE CHANGED",/)
      [illegible] GO TO [illegible]
      READ (3,1035) JR
      GO TO 003
[illegible] CONTINUE
      READ (3,1020) JC
[illegible] FORMAT([illegible])
[illegible] CONTINUE
      WRITE (3,1036) IY(JC)
 1036 FORMAT(I5,"OLD VALUE ",IX,I4,IX,"NEW VALUE ",/)
      READ (3,1037) JCN
 1037 FORMAT(I4)
      IY(JC)=JCN
      GO TO 1[illegible]
C
C     [illegible] PARENT DATA [illegible]
C
 10[illegible] CONTINUE
      DO 10[illegible]
      WRITE (3,[illegible]) IA,[illegible]
[illegible] FORMAT([illegible])
[illegible] CONTINUE
      WRITE (3,[illegible])
      [illegible] GO TO [illegible]
      READ (3,[illegible])
      GO TO [illegible]
[illegible] CONTINUE
      READ (3,[illegible])
[illegible] FORMAT([illegible])
[illegible] CONTINUE
      WRITE (3,[illegible])
[illegible] FORMAT([illegible] SMALL AREA [illegible])
      WRITE [illegible]
[illegible] FORMAT([illegible],"NEW VALUE ",[illegible])
      READ [illegible]
[illegible] FORMAT([illegible])
      [illegible]
      GO TO [illegible]
C
C     SMALL AREA DATA
C
[illegible] CONTINUE
      [illegible]
      WRITE [illegible]
      [illegible]
```



```
      WRITE (3,1099) IYB(IA),F(IA)
1099  FORMAT(T15,I4,6X,F10.0)
1100  CONTINUE
      GO TO 1080
1095  RETURN
      END
C
C     *** PRE-RECONCILIATION SUBROUTINE ***
C
      SUBROUTINE PRECON
C
      COMMON /ONE/ J,D(15),R(15),IY(15),K2,IYB(15),F(15),
     1WF(15),JA,RC(20,20),WT1(15),WT(15),F(15),NN(15,4),JCOUNT,
     2A(15),B(15),RA
C
      DO 100 I=1,4
      NN(JA,I)=NN(JCOUNT,I)
100   CONTINUE
      DO 735 IB=1,K2
      RC(JA,IB)=0
      RC(JA,IB)=F(IB)
735   CONTINUE
      RETURN
      END
C
C     *** COMPARATIVE FORECAST SUBROUTINE ***
C
      SUBROUTINE COMP
C
      COMMON /ONE/ J,D(15),R(15),IY(15),K2,IYB(15),F(15),
     1WF(15),JA,RC(20,20),WT1(15),WT(15),F(15),NN(15,4),
     2JCOUNT,A(15),B(15),RA
      COMMON /TWO/ ICOUNT,FA(15,2),SUMB,RB(15),IYE,AA,FW(15),SS(15)
C
      XY=0
      SXY=0
      SIX=0
      SX=0
      SY=0
      K5=J-1
      D1=FLOAT(IY(2) - IY(1))
      DO 1300 IE=1,J
      DT=FLOAT(IE)
      DYX=ALOG(DT)
      SIX=SIX + DYX**2
      RY=ALOG(R(IE))
      XY=DYX * RY
      SXY=SXY + XY
      SX=SX + DYX
      SY=SY + RY
1300  CONTINUE
      DNUM=(J * SXY)   SX * SY
      DENOM=(J * SIX) - SX**2
      BV=DNUM/DENOM
      DO 1305 IB=1,K2
      SS(IB)=0
      F2A=FLOAT(IYB(IB) - IY(J))
      SS(IB)=EXP(ALOG(R(J)) + (BV * ALOG(F2A))) * F(IB)
1305  CONTINUE
      DO 1320 IA=1,K2
      DO 1313 IB=1,K5
      WT1(IB)=0
      WT(IB)=0
      D(IB)=R(IB + 1)   R(IB)
1313  CONTINUE
      SUM1=0
```

```
      DBAR=0
      S1A=FLOAT(IYB(1A)   IY(J))/D1
      DO 1315 IB=1,K5
      WT1(IB)=(1./FLOAT(IYB(1A)   IY(IB + 1))) * 100
      SUM1=SUM1 + WT1(IB)
1315  CONTINUE
      DO 1317 IB=1,K5
      WT(IB)=WT1(IB)/SUM1
      DBAR=(WT(IB) * D(IB)) + DBAR
1317  CONTINUE
      PW(IA)=0
      PW(IA)=(R(J) + S1A * DBAR) * P(IA)
1320  CONTINUE
      WRITE (3,1200) (NN(JCOUNT,I),I=1,4),(PA(ICOUNT,I),I=1,2),
     1(NN(JCOUNT,I),I=1,4)
      WRITE (5,1200) (NN(JCOUNT,I),I=1,4),(PA(ICOUNT,I),I=1,2),
     1(NN(JCOUNT,I),I=1,4)
1200  FORMAT(5X,"COMPARATIVE FORECASTS FOR",1X,4A3,//
     15X,"HISTORICAL DATA",//5X,"YEAR",3X,2A6,4X,4A3)
      DO 1205 IA=1,J
      WRITE (3,1204) IY(IA),A(IA),B(IA)
      WRITE (5,1204) IY(IA),A(IA),B(IA)
1204  FORMAT(5X,I4,3X,F10.0,4X,F10.0)
1205  CONTINUE
      WRITE (3,1207) (PA(ICOUNT,I),I=1,2),(NN(JCOUNT,I),I=1,4)
      WRITE (5,1207) (PA(ICOUNT,I),I=1,2),(NN(JCOUNT,I),I=1,4)
1207  FORMAT(/5X,"FORECAST"/,12X,2A6,2X,4A3,/T32,
     1"BASIC",
     16X,"AVERAGE",7X,"RATIO",7X,"SHIFT",/5X,"YEAR",
     2T32,"RATIO",7X,"ANNUAL",2X,"DIFFERENCE",7X,"SHARE")
      DO 1209 IB=1,K2
      XI2=FLOAT(IYB(IB)   IYE)
      TEMP1=R(J)*P(IB)
      TEMP2=(XI2*AA)+1
      TEMP3=TEMP2*R(J)
      TEMP4=TEMP3*P(IB)
      WRITE (3,1208) IYB(IB),P(IB),TEMP1,
     1TEMP4,PW(IB),SS(IB)
      WRITE (5,1208) IYB(IB),P(IB),TEMP1,
     1TEMP4,PW(IB),SS(IB)
1208  FORMAT(5X,I4,3X,F10.0,4X,F10.0,3X,F10.0,2X,F10.0,
     12X,F10.0)
1209  CONTINUE
      RETURN
      END
C
C     *** WRITE DATA TO FILE SUBROUTINE ***
C
      SUBROUTINE FILEIN
C
      COMMON /ONE/ J,D(15),R(15),IY(15),K2,IYB(15),P(15),
     1WF(15),JA,RC(20,20),WT1(15),WT(15),F(15),NN(15,4),
     2JCOUNT,A(15),B(15),RA
C
      WRITE(5,900)
900   FORMAT(1X,"IWR RATIO FORECAST PROGRAM.  WRITTEN FOR THE",/
     1"HARRIS 120 SYSTEM BY MARK DUNNING AND KEVIN ALEXANDER.",/
     2"VERSION 1.1 JANUARY 1984",//)
      WRITE(5,935)
935   FORMAT(//,5X,"INPUT VALUES ARE AS FOLLOWS:",//
     1T15,"YEAR",5X,"PARENT AREA",5X,"SMALL AREA")
      DO 955 IA=1,J
      WRITE(5,940) IY(IA),A(IA),B(IA)
940   FORMAT(T15,I4,6X,F10.0,6X,F10.0)
955   CONTINUE
      WRITE(5,932)
```

```
791 992   FORMAT(//,T23,"FORECAST DATA",//T15,"YEAR",5X,"PARENT AREA",/)
792       DO 994 IA=1,K2
793       WRITE(5,996) IYB(IA),P(IA)
794 996   FORMAT(T15,I4,6X,F10.0)
795 994   CONTINUE
796       RETURN
797       END
EOF..
EOT..
```

END

DATE
FILMED

7-84

DTIC